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Genetic evaluation of Canadian dairy bulls for milking speed with an animal model

Banos, G. and Burnside, E.B. 1992. **Genetic evaluation of Canadian dairy bulls for milking speed with an animal model.** Can. J. Anim. Sci. **72**: 169–172. Bull proofs for milking speed were computed under an animal model for five dairy breeds. Data were subjective scores on first lactation cows from all milk recording agencies across Canada. There were 1411 Holstein, 171 Ayrshire, 85 Jersey, 31 Guernsey, and 17 Brown Swiss bulls that received official evaluations. Bull proofs were expressed on a linear scale from 1 to 9, where 9 designated bulls with the fastest milking daughters. The biological significance of these proofs was investigated using 6965 weekly cow records of total milking time, average flow rate, and peak flow. Data were on 119 Holstein cows by 41 officially proven sires. Increases in proofs of 1 point on the linear scale were associated with decreases in total milking time of 20 s and increases of 64 g min^{-1} and 140 g in average and peak flow, respectively.

Key words: Milking speed, animal model, national evaluation, dairy bulls

Banos, G. et Burnside, E. B. 1992. **Évaluation génétique des taureaux laitiers pour la rapidité de la traite utilisant un modèle animal.** Can. J. Anim. Sci. **72**: 169–172. Des indices de contrôle des taureaux pour la rapidité de traite de leurs filles ont été traités par ordinateur selon un modèle animal conçu pour cinq races laitières. Les données consistaient en cotes sugestives attribuées à des vaches de première lactation par tous les organismes de contrôle laitier du Canada. En tout, 1411 taureaux Holstein, 171 Ayrshire, 85 Jersey, 31 Guernsey et 17 Suisse brune disposaient de relevés d'évaluation officielle. Les cotes étaient transposées sur une échelle linéaire de 1 à 9, 9 désignant les taureaux dont les filles avaient la plus grande rapidité de traite. La signification biologique de ces cotes a été examinée à partir de 6965 relevés hebdomadaires de production des vaches: durée totale de traite, vitesse d'écoulement moyen et écoulement maximum. Ces données portaient sur 119 vaches Holstein issues de 41 taureaux officiellement confirmés. Des gains des indices de 1 point sur l'échelle linéaire correspondaient à des diminutions de 20 secondes dans la durée totale de la traite et à des accroissements respectifs de 64 g min^{-1} et de 140 g pour le débit moyen et pour le débit maximum d'écoulement.

Mots clés: Rapidité de traite, modèle animal, évaluation à l'échelle nationale, taureaux laitiers

Milking speed of dairy cows may have a considerable economic influence on the success of a dairy enterprise (Sivarajasingam et al. 1984). Several measures of milking speed have been investigated (Blake and McDaniel 1978; Williams et al. 1984). Heritability estimates for most measures were over 0.20. Therefore, genetic evaluation of bulls for milking speed could provide the means to identify sires whose daughers are expected to be slow or fast milkers. Research results on the scope for a subjective scoring of milking speed have suggested that a Best Linear Unbiased Prediction (BLUP) sire evaluation scheme could be implemented in Canada based on subjective scores in early lactation (Meyer and Burnside 1987). The objectives of this study were: (1) to develop a system to evaluate Canadian dairy bulls for milking speed under an animal model, and (2) to determine the biological significance of bull proofs.

To address the first objective, data were collected from the Record of Performance and Dairy Herd Improvement Cooperatives of Ontario, Quebec, Alberta, and British Columbia. Each lactation record included the producer's subjective assessment of the cow's milking speed categorized as "very slow", "slow", "average", "fast", or "very fast". First lactations from 1981 to 1990 representing 277 936 Holstein (HOL), 19 641 Ayrshire (AYR), 8952 Jersey (JER), 2545 Guernsey (GUE), and 1045 Brown Swiss (BSW) cows by 9562, 1260, 810, 238, and 152 sires, respectively, were analyzed.

Subjective scores were expressed in categories from 1 to 5 and were transformed to normally distributed scores using the Snell procedure (Snell 1964). An animal model utilizing relationships among all animals was used for the evaluation. Effects considered in the model were herd-by-calving-year interaction, calving season, age at calving, stage of lactation, and animal. The heritability of subjective milking speed score was assumed to be 0.21 based on estimates reported by Meyer and Burnside (1987). The algorithm developed used Gauss-Seidel iteration on the fixed effects (environmental) and Jacobi iteration on the random effects (animal); both using interation on the data techniques (Schaeffer and Kennedy 1986).

A bull evaluation was considered official if it was based on daughter records in at least 10 herds and had minimum repeatability of 55%. Cow evaluations were not published. Repeatability was estimated using a procedure described by Meyer (1989).

Correlations for evaluations of officially proven bulls between the animal model and the sire model used previously were 0.93 for HOL and 0.83 to 0.90 for the other breeds. These correlations were similar to those observed for other traits (production, conformation) when comparing animal model and sire model evaluations (Westell and Van Vleck 1987; Meyer and Burnside 1988).

Bull proofs were expressed on a linear scale from 1 to 9, 9 designating sires with the fastest milking daughters. Linear scale proof categories were assigned based upon the distribution of solutions of bulls meeting the official proof criteria. Extreme ratings, i.e., 1 and 9, represented bulls whose solutions were at least 3 standard deviations away from the mean. Distributions of officially proven bulls, by breed, are given in Table 1.

The second objective was to determine the biological significance of the linear scale proof categories, expressed in terms of actual milking time or rate of milk delivery. To address this issue, weekly records were obtained from the Colleges of Agricultural Technology in New Liskeard and Ridgetown. There were 6965 records for 119 HOL cows by 41 officially proven HOL sires, including information on total milking time (TMT), average flow rate (AVFL), and peak flow (PKFL). Means, standard deviations and units of measurement for these traits are shown in Table 2. The distribution of the 41 sires by linear scale proof category was comparable to the distribution of all officially proven Holstein sires. Records were adjusted with a model that included herd-by-calving-year interaction, calving season, age at calving, stage of lactation, and milk yield. Mean within-sire residuals from this model provided daughter averages corrected for the above effects. These daughter averages, expressed as deviations from the overall mean, were then regressed on linear score sire proofs. Slopes of the regressions and standard errors are shown in Table 3. The amount of variation explained by the regression, expressed by the R-square term, is also shown in

Table 1. Distribution of numbers of bulls with official proofs by linear score category for the five breeds

	Score	AYR	BSW	GUE	HOL	JER
Slow	1	0	0	0	10	0
	2	4	1	0	22	1
	3	12	1	3	97	7
	4	43	3	6	311	19
Average	5	51	6	13	493	29
	6	48	5	7	344	18
	7	11	1	1	117	10
	8	2	0	1	16	1
Fast	9	0	0	0	1	0

Table 2. Means, standard deviations, and units of measurement for total milking time (TMT), average flow rate (AVFL), and peak flow (PKFL)

Trait	Mean	Standard deviation	Units of measurement
TMT	7.47	2.64	min
AVFL	1.82	0.61	kg min^{-1}
PKFL	3.83	1.23	kg

Table 3. Slopes of regressions of daughter average total milking time (TMT), average flow rate (AVFL), and peak flow (PKFL) on linear score bull proofs (standard errors in parentheses) and *R*-square values of the regressions

Trait	Slope	*R*-square
TMT	−0.33 (0.11)	0.17
AVFL	0.06 (0.02)	0.21
PKFL	0.14 (0.04)	0.18

Table 3. The *R*-square is equivalent to the square of the multiple correlation coefficient between sire proofs as linear subjective scores and daughter average objective measures (TMT, AVFL, PKFL). The expected *R*-square is a function of the genetic correlation between the objective measures and the subjective score, the heritability of the objective measures and the number of daughter records per sire that make up his daughter average. If the sires are unrelated and sire proofs have accuracy equal to unity, the expected *R*-square is:

$$R\text{-square expected} = (0.25)\ nh^2(RG^2)$$

where n is the average number of daughters per sire for the objective measure, h^2 the heritability of the objectively measured trait and RG the genetic correlation between subjective scores and objective measures. The average number of daughters per sire was low, approximately 3, because these data were difficult to collect. Based on estimates of RG for Snell transformed subjective scores and TMT of 0.92 and h^2 for TMT of 0.25 (McClelland 1983), the expected *R*-square was 0.15. Slightly higher *R*-square reported here are due to relationships between sires. Estimates of RG between subjective scores and AVFL and PKFL have not been reported. In this case the squared accuracy of all sire proofs were over 0.90. A test for curvilinearity of regression revealed a nonsignificant quadratic effect of proof on daughter average.

According to these slopes, a sire proof of 5 (average) indicates an average expected future daughter performance in TMT, AVFL, and PKFL. An increase in a HOL sire proof by 1 point on the linear scale would be associated with a 20 s decrease in TMT, a 64 g min^{-1} increase in AVFL, and a 140 g increase in PKFL. These estimates are unbiased and significantly different from zero. These estimates also represent improvement of 3.5-4% of the mean in all cases.

This project resulted in the establishment of a national sire evaluation for milking speed in Canada using an animal model and subjective scores. Using a limited amount of electronic measures of milking speed, biologically meaningful relationships were found with the linear scale sire proofs.

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